

**CoolMOS™ Power Transistor**
**Features**

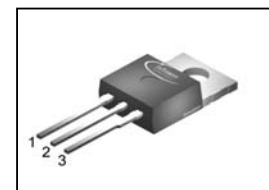
- Worldwide best  $R_{ds,on}$  in TO220
- Ultra low gate charge
- Extreme dv/dt rated
- High peak current capability
- Qualified according to JEDEC<sup>(1)</sup> for target applications
- Pb-free lead plating; RoHS compliant

**CoolMOS CP is specially designed for:**

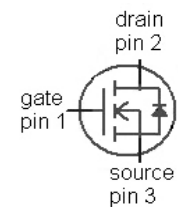
- Hard switching SMPS topologies for Server and Telecon

**Product Summary**

|                      |       |          |
|----------------------|-------|----------|
| $V_{DS} @ T_{j,max}$ | 650   | V        |
| $R_{DS(on),max}$     | 0.099 | $\Omega$ |
| $Q_{g,typ}$          | 60    | nC       |

**PG-TO220**


| Type        | Package  | Ordering Code | Marking |
|-------------|----------|---------------|---------|
| IPP60R099CP | PG-TO220 | SP000057021   | 6R099   |


**Maximum ratings, at  $T_j=25\text{ °C}$ , unless otherwise specified**

| Parameter  | Symbol         | Conditions                               | Value       | Unit               |
|--|----------------|--|-------------|--------------------|
| Continuous drain current                                 | $I_D$          | $T_C=25\text{ °C}$                       | 31          | A                  |
|  |                | $T_C=100\text{ °C}$                      | 19          |                    |
| Pulsed drain current <sup>(2)</sup>                      | $I_{D,pulse}$  | $T_C=25\text{ °C}$                       | 93          |                    |
| Avalanche energy, single pulse                           | $E_{AS}$       | $I_D=11\text{ A}$ , $V_{DD}=50\text{ V}$ | 800         | mJ                 |
| Avalanche energy, repetitive $t_{AR}$ <sup>(2),3)</sup>  | $E_{AR}$       | $I_D=11\text{ A}$ , $V_{DD}=50\text{ V}$ | 1.2         |                    |
| Avalanche current, repetitive $t_{AR}$ <sup>(2),3)</sup> | $I_{AR}$       |  | 11          | A                  |
| MOSFET dv/dt ruggedness                                  | dv/dt          | $V_{DS}=0\dots480\text{ V}$              | 50          | V/ns               |
| Gate source voltage                                      | $V_{GS}$       | static                                   | $\pm 20$    | V                  |
|  |                | AC ( $f>1\text{ Hz}$ )                   | $\pm 30$    |                    |
| Power dissipation  | $P_{tot}$      | $T_C=25\text{ °C}$                       | 255         | W                  |
| Operating and storage temperature                        | $T_j, T_{stg}$ |  | -55 ... 150 | $^{\circ}\text{C}$ |
| Mounting torque  |                | M3 and M3.5 screws                       | 60          | Ncm                |

**Maximum ratings, at  $T_j=25\text{ °C}$ , unless otherwise specified**

| Parameter                           | Symbol        | Conditions         | Value | Unit |
|-------------------------------------|---------------|--------------------|-------|------|
| Continuous diode forward current    | $I_S$         | $T_C=25\text{ °C}$ | 18    | A    |
| Diode pulse current <sup>2)</sup>   | $I_{S,pulse}$ |                    | 93    |      |
| Reverse diode $dv/dt$ <sup>4)</sup> | $dv/dt$       |                    | 15    | V/ns |

| Parameter | Symbol | Conditions | Values |      |      | Unit |
|-----------|--------|------------|--------|------|------|------|
|           |        |            | min.   | typ. | max. |      |

**Thermal characteristics**

|  |            |                                       |   |   |     |     |
|--|------------|---------------------------------------|---|---|-----|-----|
| Thermal resistance, junction - case                        | $R_{thJC}$ |                                       | - | - | 0.5 | K/W |
| Thermal resistance, junction - ambient                     | $R_{thJA}$ | leaded                                | - | - | 62  |     |
| Soldering temperature, wavesoldering only allowed at leads | $T_{sold}$ | 1.6 mm (0.063 in.) from case for 10 s | - | - | 260 | °C  |

**Electrical characteristics, at  $T_j=25\text{ °C}$ , unless otherwise specified**
**Static characteristics**

|                                  |               |   |     |      |       |               |
|----------------------------------|---------------|---|-----|------|-------|---------------|
| Drain-source breakdown voltage   | $V_{(BR)DSS}$ | $V_{GS}=0\text{ V}$ , $I_D=250\text{ }\mu\text{A}$                | 600 | -    | -     | V             |
| Gate threshold voltage           | $V_{GS(th)}$  | $V_{DS}=V_{GS}$ , $I_D=1.2\text{ mA}$                             | 2.5 | 3    | 3.5   |               |
| Zero gate voltage drain current  | $I_{DSS}$     | $V_{DS}=600\text{ V}$ , $V_{GS}=0\text{ V}$ , $T_j=25\text{ °C}$  | -   | -    | 5     | $\mu\text{A}$ |
|                                  |               | $V_{DS}=600\text{ V}$ , $V_{GS}=0\text{ V}$ , $T_j=150\text{ °C}$ | -   | 50   | -     |               |
| Gate-source leakage current      | $I_{GSS}$     | $V_{GS}=20\text{ V}$ , $V_{DS}=0\text{ V}$                        | -   | -    | 100   | nA            |
| Drain-source on-state resistance | $R_{DS(on)}$  | $V_{GS}=10\text{ V}$ , $I_D=18\text{ A}$ , $T_j=25\text{ °C}$     | -   | 0.09 | 0.099 | $\Omega$      |
|                                  |               | $V_{GS}=10\text{ V}$ , $I_D=18\text{ A}$ , $T_j=150\text{ °C}$    | -   | 0.24 | -     |               |
| Gate resistance                  | $R_G$         | $f=1\text{ MHz}$ , open drain                                     | -   | 1.3  | -     | $\Omega$      |

| Parameter | Symbol | Conditions | Values |      |      | Unit |
|-----------|--------|------------|--------|------|------|------|
|           |        |            | min.   | typ. | max. |      |

**Dynamic characteristics**

|  |              |   |   |      |   |    |
|--|--------------|---|---|------|---|----|
| Input capacitance  | $C_{iss}$    | $V_{GS}=0\text{ V}, V_{DS}=100\text{ V},$<br>$f=1\text{ MHz}$                         | - | 2800 | - | pF |
| Output capacitance   | $C_{oss}$    |   | - | 130  | - |    |
| Effective output capacitance, energy related <sup>5)</sup> | $C_{o(er)}$  | $V_{GS}=0\text{ V}, V_{DS}=0\text{ V}$<br>to 480 V                                    | - | 130  | - |    |
| Effective output capacitance, time related <sup>6)</sup>   | $C_{o(tr)}$  |   | - | 340  | - |    |
| Turn-on delay time   | $t_{d(on)}$  | $V_{DD}=400\text{ V},$<br>$V_{GS}=10\text{ V}, I_D=18\text{ A},$<br>$R_G=3.3\ \Omega$ | - | 10   | - | ns |
| Rise time  | $t_r$        |   | - | 5    | - |    |
| Turn-off delay time  | $t_{d(off)}$ |   | - | 60   | - |    |
| Fall time  | $t_f$        |   | - | 5    | - |    |

**Gate Charge Characteristics**

|                       |               |   |   |     |    |    |
|-----------------------|---------------|---|---|-----|----|----|
| Gate to source charge | $Q_{gs}$      | $V_{DD}=400\text{ V}, I_D=18\text{ A},$<br>$V_{GS}=0\text{ to }10\text{ V}$ | - | 14  | -  | nC |
| Gate to drain charge  | $Q_{gd}$      |   | - | 20  | -  |    |
| Gate charge total     | $Q_g$         |   | - | 60  | 80 |    |
| Gate plateau voltage  | $V_{plateau}$ |   | - | 5.0 | -  | V  |

**Reverse Diode**

|                               |           |   |   |     |     |               |
|-------------------------------|-----------|---|---|-----|-----|---------------|
| Diode forward voltage         | $V_{SD}$  | $V_{GS}=0\text{ V}, I_F=18\text{ A},$<br>$T_j=25\text{ }^\circ\text{C}$ | - | 0.9 | 1.2 | V             |
| Reverse recovery time         | $t_{rr}$  | $V_R=400\text{ V}, I_F=I_S,$<br>$di_F/dt=100\text{ A}/\mu\text{s}$      | - | 450 | -   | ns            |
| Reverse recovery charge       | $Q_{rr}$  |   | - | 12  | -   | $\mu\text{C}$ |
| Peak reverse recovery current | $I_{rrm}$ |   | - | 70  | -   | A             |

<sup>1)</sup> J-STD20 and JESD22

<sup>2)</sup> Pulse width  $t_p$  limited by  $T_{j,max}$

<sup>3)</sup> Repetitive avalanche causes additional power losses that can be calculated as  $P_{AV}=E_{AR} \cdot f$ .

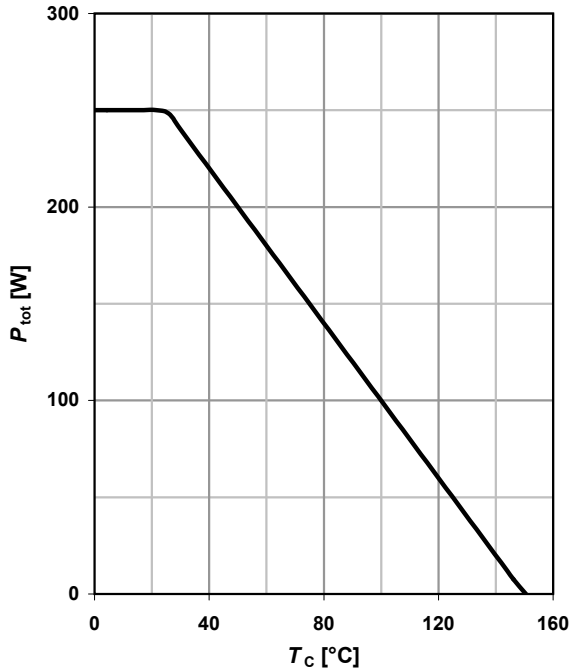
<sup>4)</sup>  $I_{SD} \leq I_D, di/dt \leq 100\text{ A}/\mu\text{s}, V_{DClink} = 400\text{ V}, V_{peak} < V_{(BR)DSS}, T_j < T_{j,max}$ , identical low side and high side switch

<sup>5)</sup>  $C_{o(er)}$  is a fixed capacitance that gives the same stored energy as  $C_{oss}$  while  $V_{DS}$  is rising from 0 to 80%  $V_{DSS}$ .

<sup>6)</sup>  $C_{o(tr)}$  is a fixed capacitance that gives the same charging time as  $C_{oss}$  while  $V_{DS}$  is rising from 0 to 80%  $V_{DSS}$ .

**1 Power dissipation**

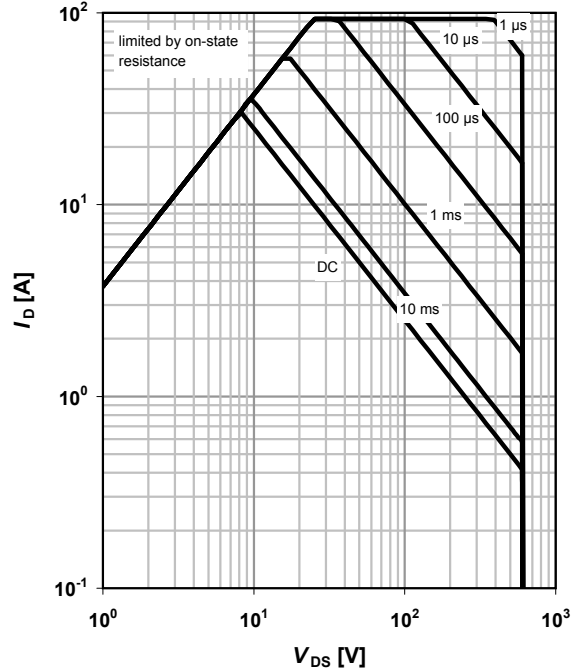
$P_{tot}=f(T_C)$



**2 Safe operating area**

$I_D=f(V_{DS}); T_C=25\text{ °C}; D=0$

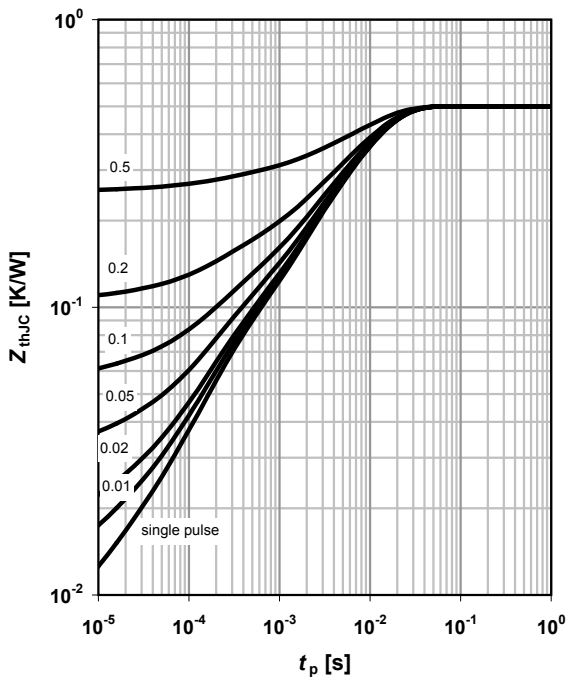
parameter:  $t_p$



**3 Max. transient thermal impedance**

$Z_{thJC}=f(t_p)$

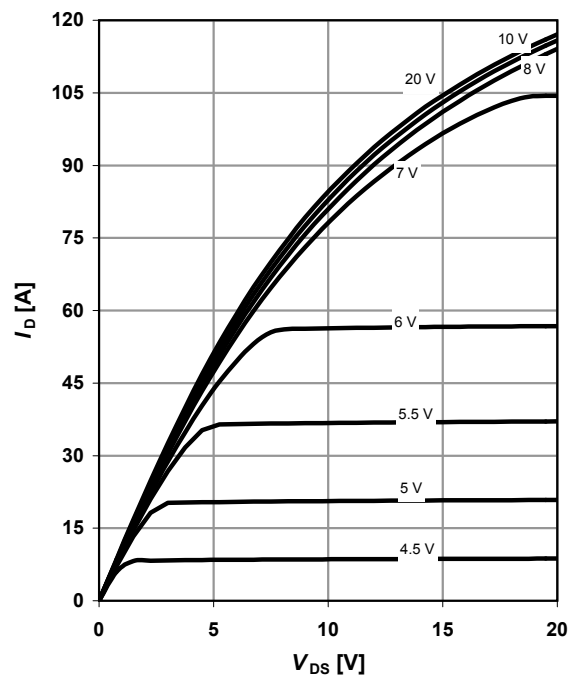
parameter:  $D=t_p/T$



**4 Typ. output characteristics**

$I_D=f(V_{DS}); T_j=25\text{ °C}$

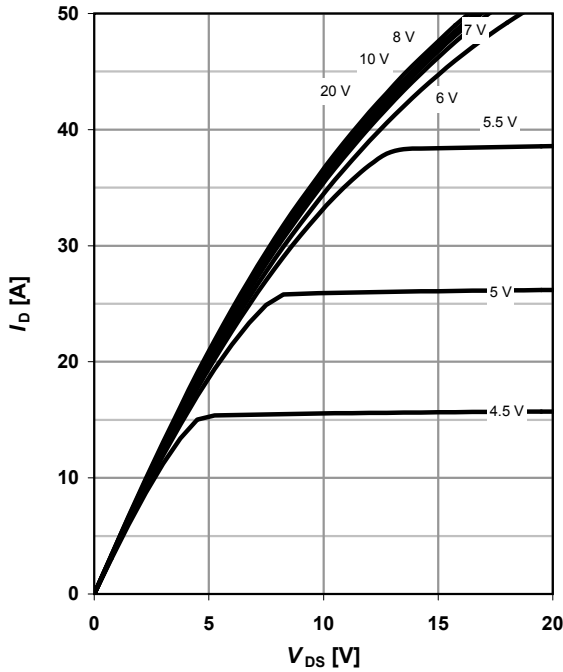
parameter:  $V_{GS}$



**5 Typ. output characteristics**

$I_D = f(V_{DS}); T_j = 150\text{ }^\circ\text{C}$

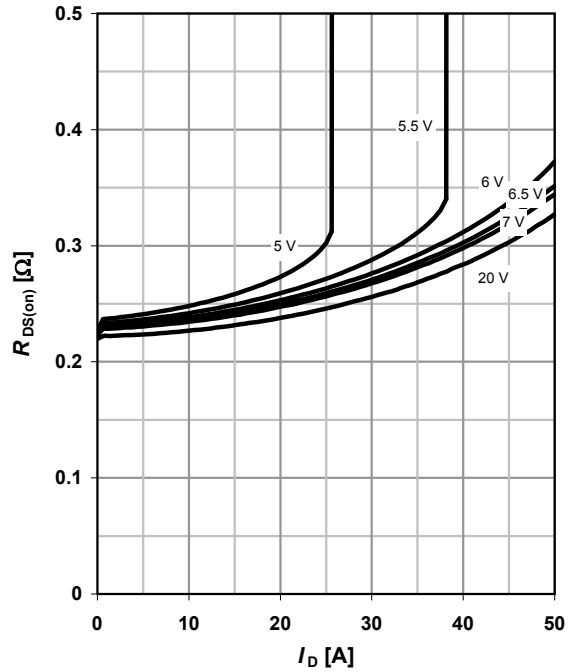
parameter:  $V_{GS}$



**6 Typ. drain-source on-state resistance**

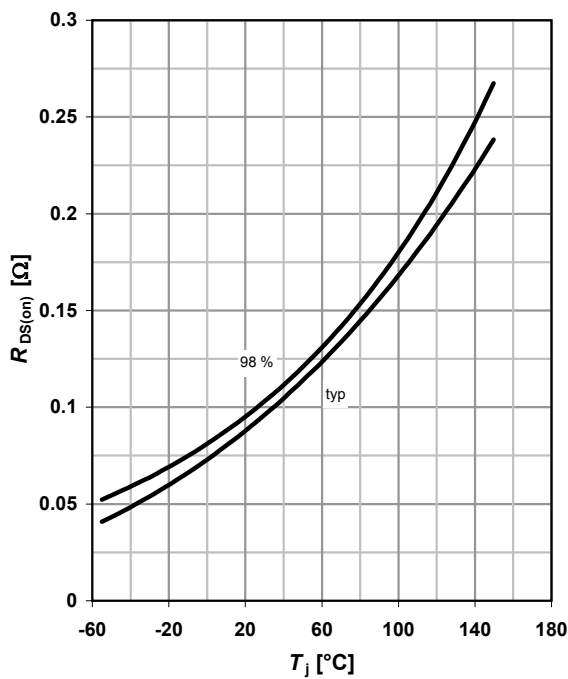
$R_{DS(on)} = f(I_D); T_j = 150\text{ }^\circ\text{C}$

parameter:  $V_{GS}$



**7 Drain-source on-state resistance**

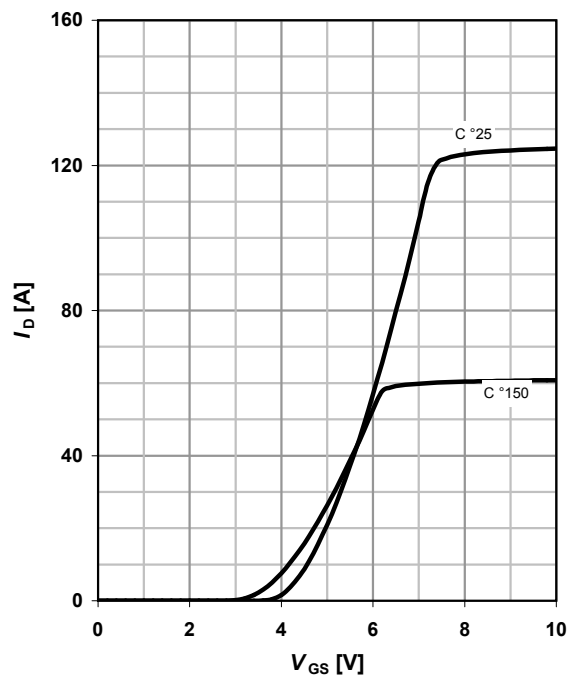
$R_{DS(on)} = f(T_j); I_D = 18\text{ A}; V_{GS} = 10\text{ V}$



**8 Typ. transfer characteristics**

$I_D = f(V_{GS}); |V_{DS}| > 2I_D/R_{DS(on)max}$

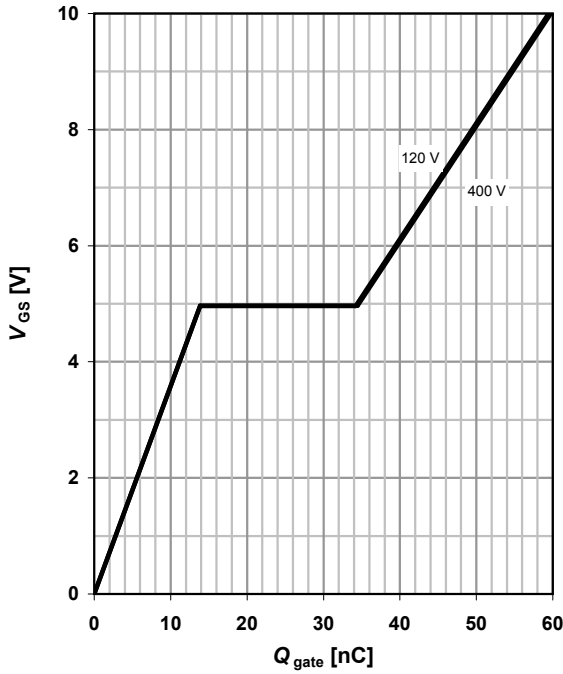
parameter:  $T_j$



**9 Typ. gate charge**

$V_{GS}=f(Q_{gate}); I_D=18\text{ A pulsed}$

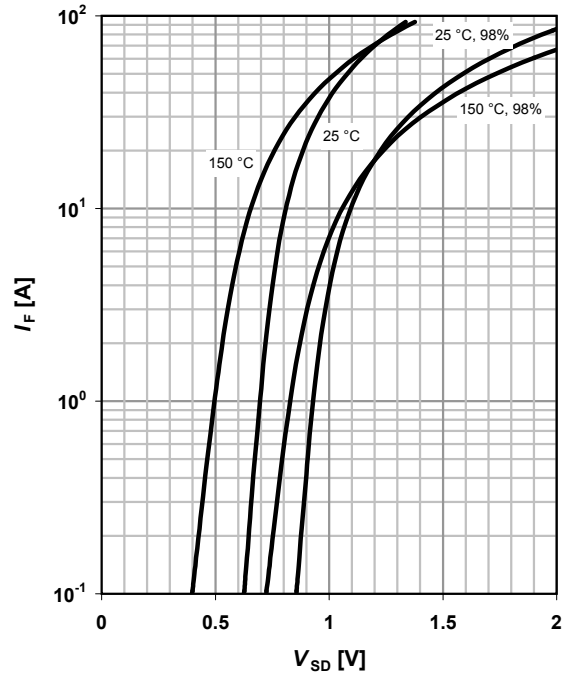
parameter:  $V_{DD}$



**10 Forward characteristics of reverse diode**

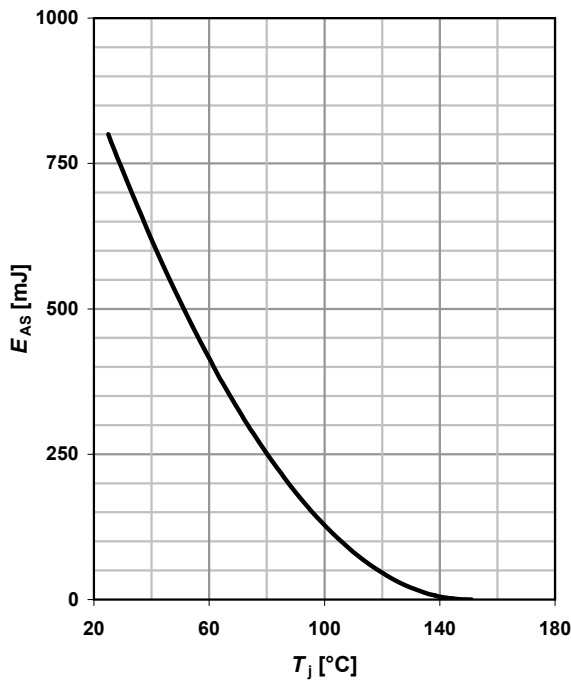
$I_F=f(V_{SD})$

parameter:  $T_j$



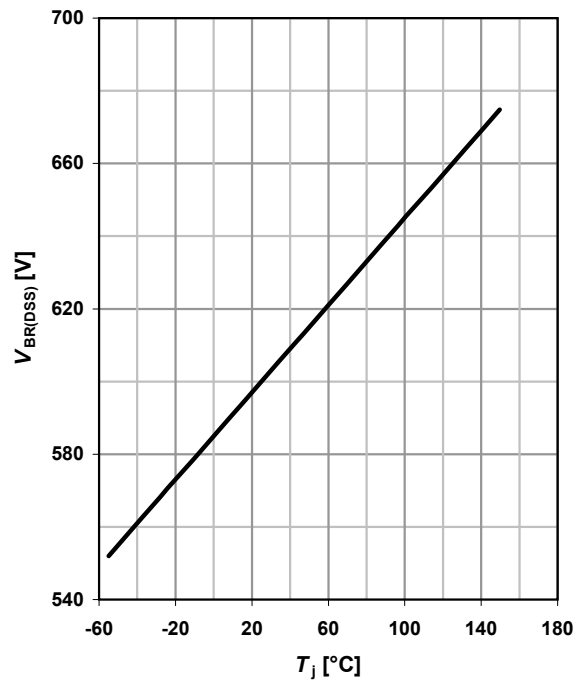
**11 Avalanche energy**

$E_{AS}=f(T_j); I_D=11\text{ A}; V_{DD}=50\text{ V}$



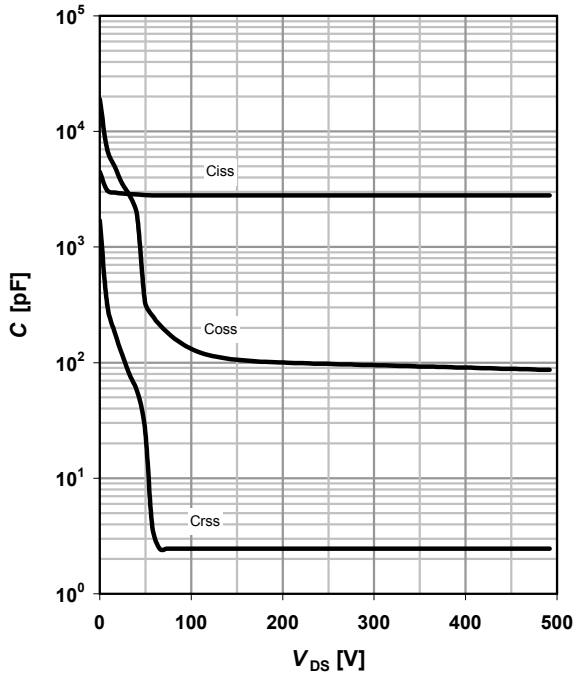
**12 Drain-source breakdown voltage**

$V_{BR(DSS)}=f(T_j); I_D=0.25\text{ mA}$



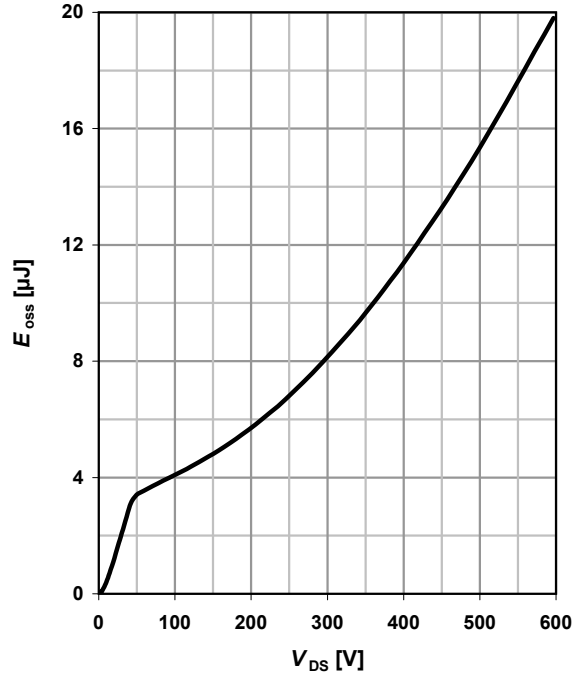
13 Typ. capacitances

$C=f(V_{DS}); V_{GS}=0\text{ V}; f=1\text{ MHz}$



14 Typ. Coss stored energy

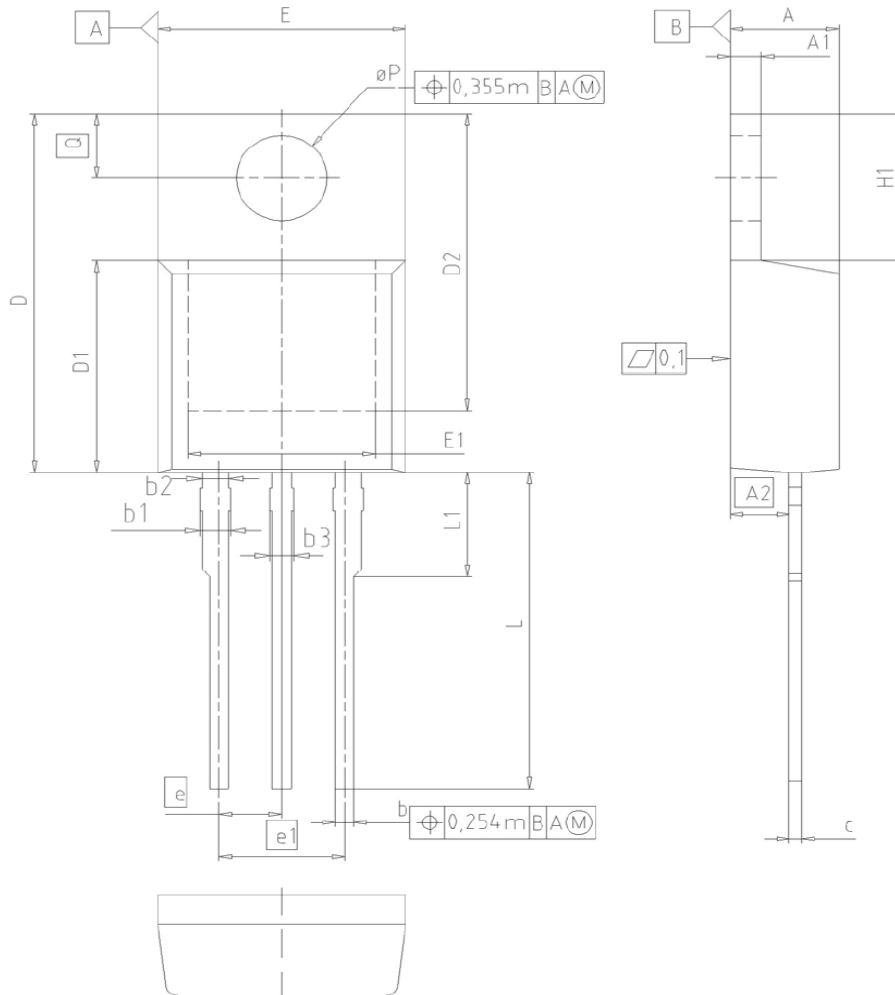
$E_{oss}=f(V_{DS})$



Definition of diode switching characteristics





**PG-TO220-3-1/TO220-3-21: Outlines**


| DIM      | MILLIMETERS |       | INCHES |       |
|----------|-------------|-------|--------|-------|
|          | MIN         | MAX   | MIN    | MAX   |
| A        | 4.30        | 4.57  | 0.169  | 0.180 |
| A1       | 1.17        | 1.40  | 0.046  | 0.055 |
| A2       | 2.15        | 2.72  | 0.085  | 0.107 |
| b        | 0.65        | 0.86  | 0.026  | 0.034 |
| b1       | 0.95        | 1.40  | 0.037  | 0.055 |
| b2       | 0.95        | 1.15  | 0.037  | 0.045 |
| b3       | 0.65        | 1.15  | 0.026  | 0.045 |
| c        | 0.33        | 0.60  | 0.013  | 0.024 |
| D        | 14.81       | 15.95 | 0.583  | 0.628 |
| D1       | 8.51        | 9.45  | 0.335  | 0.372 |
| D2       | 12.19       | 13.10 | 0.480  | 0.516 |
| E        | 9.70        | 10.36 | 0.382  | 0.408 |
| E1       | 6.50        | 8.60  | 0.256  | 0.339 |
| e        | 2.54        |       | 0.100  |       |
| e1       | 5.08        |       | 0.200  |       |
| N        | 3           |       | 3      |       |
| H1       | 5.90        | 6.90  | 0.232  | 0.272 |
| L        | 13.00       | 14.00 | 0.512  | 0.551 |
| L1       | -           | 4.80  | -      | 0.189 |
| $\phi P$ | 3.60        | 3.89  | 0.142  | 0.153 |
| Q        | 2.60        | 3.00  | 0.102  | 0.118 |

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**SCALE** 0 2.5 5mm

**EUROPEAN PROJECTION**

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